The health-related quality of life and cost implications of falls in elderly women

C. P. Iglesias · A. Manca · D. J. Torgerson

Abstract

Summary Fractures and falls are serious cause of morbidity and cost to society. Our results suggest that the main burden to morbidity, measured as impact on health-related quality of life, is due to fear of falling rather than falls or their sequelae, such as fractures.

Introduction Fractures and falls are serious cause of morbidity and cost to society. We investigated the impact on health-related quality of life (HRQoL) associated with falls, fractures and fear of falling and falls and fractures cost.

Methods Three datasets providing longitudinal data on fear of falling, HRQoL and a common set of baseline risk factors for fracture (smoking status, weight and age) were analysed. Multilevel random effects models were used to estimate the long-term impact on HRQoL associated with falls, fractures and fear of falling. Healthcare resource use primary data were collected to estimate falls and fractures cost.

Results Older, low weight and smoking women reported lower HRQoL. The impact on HRQoL of a fracture was at least twice as large as that associated with falls. The largest negative effect on HRQoL was associated with self-reported fear of falling. The cost of falls was £1088. Similarly, the cost of falls leading to a fracture was £15,133, £2,753, £1,863, £1,331 and £3,498 for hip, wrist, arm, vertebral and other fractures, respectively.

Discussion The main burden to morbidity is due to fear of falling. Interventions aimed at reducing fear of falling may produce larger gains in HRQoL.

Keywords EQ-5D · Falls · Fear of falling · Multilevel modelling · Quality of life

C. P. Iglesias (✉)
Department of Health Sciences, University of York,
Seebohm Rowntree Building Room 148,
York YO10 5DD, UK
e-mail: cpiu1@york.ac.uk

A. Manca
Centre for Health Economics, University of York,
Alcuin A, Room A118,
York YO10 5DD, UK
e-mail: am126@york.ac.uk

C. P. Iglesias
Centre for Health Economics, University of York,
Alcuin A,
York YO10 5DD, UK

D. J. Torgerson
Department of Health Sciences, University of York,
Seebohm Rowntree Building,
York YO10 5DD, UK
e-mail: djt6@york.ac.uk

Introduction

Fractures and falls are serious cause of morbidity and cost to society [1]. In the UK, the importance of fall-related injuries has been recognised in the recently published National Service Framework (NSF) for Older People [2]. The NSF calls for health improvement plans to be devised that will reduce the burden of fall-related injuries. A previous study estimated the cost burden of fractures to society in the region of £1.8 billion [3] ($2.8US billion and €2.5 billion, 2003 PPP [4]). The hip fracture cost estimate was partly based on patient-level data but non-hip fracture costs and were largely based on published estimates from aggregated data, and therefore, may not be entirely accurate. Furthermore, of equal importance is the health-related quality life (HRQoL) loss due to falls, fear of falling as well as hip and other fall-related fractures.

Between 1993 and 2006, fracture costs reported in the literature have been estimated from a variety of sources such as expert opinion [5, 6], medical records [7–9] and decision models [10]. Only one study has reported to have collected patient-level resource use data [11]. However, the mean age of the patients participating in that study was 55 years, considerably younger than the group of patients considered at higher risk of fracture, i.e. women aged 70 years and over. These cost estimates, derived from a cohort of relatively young women, are likely to underestimate the fracture costs of women aged 70 years and over, who represent the majority of fracture cases. The cost of falls that do not cause a fracture is relatively unknown. However, because the incidence of falls is higher than that of fractures [12–14] even if they were associated with relatively slight costs and poorer quality of life, this would be a considerable burden. As well as increasing costs, of [12] more importance is the impact fractures have upon HRQoL. A systematic review conducted in 2003 found that most economic studies of treatments for fracture prevention have not used patient-derived quality of life [15]. The impact of both falls and fear of falling has not been quantified. The aim of this study is to use an opportunistic sample of UK women to assess the impact of falls, fracture and fear of falling on costs and generic quality of life.

Materials and methods

Individual patient-level data from two randomised controlled trials and one cohort study conducted by one of the authors in the field of fracture prevention were used to explore the impact of falls and fractures on HRQoL, as measured by the EuroQol-5D (EQ-5D) [16] questionnaire. The EQ-5D 'utility' scores range from −0.594 to 1, where a value of 'one' indicates perfect health, 'zero' represents dead and negative values indicate that individuals perceive those health states as worse than dead [17]. The interval properties of this instrument make it useful within economic evaluations of healthcare technologies [17]. The main characteristics of the data sets used are described below.

Hip protector study This is a pragmatic, randomised trial of hip protectors for the prevention of hip fractures among women living in the community [18]. Women aged 70 years and over with one or more risk factors for hip fracture (low body weight, current smoker, prior fracture, family history of hip fracture) were eligible. Furthermore, data on fear of falling were measured on a six-level Likert scale that went from stating to have been worried about falling 'all of the time' to have been worried 'none of the time' [19]. Four thousand one hundred and ninety-six women were recruited into this study (mean age 77.8 years). Participants were

followed-up for a minimum of 2 years and a maximum of 42 months (median follow-up 28 months). Data on fracture and fall incidence, risk factors for fracture, i.e. weight, age, smoking status, HRQoL, were collected at baseline and at six monthly intervals after that.

Calcium and vitamin D study This is a pragmatic, open, randomised, controlled study of calcium and cholecalciferol (vitamin D_3) for prevention of fractures in primary care [12]. A total of 3,314 women were recruited into this study (mean age 76.8 years). Women aged 70 years and over with one of more risk factors for hip fracture [any previous fracture, low body weight (less than 58 kg), current smoker, family history of hip fracture, fair or poor self-reported health] were eligible. Data on fracture and fall incidence, HRQoL measured with the EQ-5D and fear of falling measured on the same six-level Likert scale used in the *hip protector* study were collected at baseline and every 6 months after that for a minimum of 2 years and a maximum of 42 months (mean follow-up 25 months).

Epidemiological risk factors study This was a prospective, comprehensive, cohort study of women aged 70 years and over living in North Yorkshire and Cumbria regions in England [20]. Four thousand two hundred and ninety-two women were recruited into this study (mean age 76.9). Data on risk fractures for fracture (personal history of previous fracture, family history of hip fracture, low body weight, i.e. less than 58 kg, smoking status), incidence of falls and fractures were measured at baseline and on a 12-month basis for 24 months. As for the previous studies, the authors collected individual-level data on HRQoL and fear of falling using the same Likert scale used in the hip protector study. Although the study collected these data at three different time points, the present application includes measurements at the first and second follow-ups when data on HRQoL were collected. This was necessary in order to ensure comparability with the other two case studies. This study sample also includes a subgroup of participants from the hip protector trial. This is because two of the larger centres from the hip protector study also recruited participants for the epidemiological cohort study. Thus, all women aged 70+ who either consented for the hip protector trial or the cohort study were included.

Resource use data collection

A fall and fracture questionnaire was designed and administered to individuals (*N*=1190) participating in the *calcium and vitamin D* trial who had previously indicated to be willing to be contacted in the future for research purposes. Participants were asked whether in the last

12 months they had experienced a fall and/or a fracture, the number of times they had seen a doctor, GP or consultant and whether they had been hospitalised for reasons other than a fall or fracture and for how long. In addition, those participants having experienced either a fall or a fracture were also asked about whether they had been hospitalised and their length of stay in hospital, the number of times they had seen a doctor or nurse, whether they had changed residence as a consequence of their fall and/or fracture and for how long. Finally, they were asked to describe any treatments that had been specifically prescribed for their fall or fracture over the same 12-month period.

Resource use was valued using routinely published UK national data to estimate the economic impact of falls and fracture in the sample of patients enrolled in the vitamin D trial. Table 1 lists the unit costs associated with the key resource use. Hospital inpatient length of stay was costed using NHS reference costs [21], which represent fully allocated cost estimates, as opposed to purely 'hotel costs'. Similarly, the cost of surgery following hip, wrist, arm and vertebral fractures were also obtained from the NHS reference cost. Specialist contact visits were valued using the costs indicated in the Chartered Institute of Public Finance and Accountancy (CIPFA) data base [22], while GP and nurse visits, residential accommodation and the

cost of home help were valued using the figures routinely produced from the Personal and Social Services Research Unit at the University of Canterbury [23].

Analysis

Descriptive statistics were obtained to assess the similarity of the patients' sample in the three studies. Where three or more measurements per individual were available, a hierarchical (multilevel) regression model was used to analyse the data and account for the longitudinal collection of the outcome (i.e. quality of life measure), which was expected to display high within subject correlation. This modelling strategy facilitates the analysis of the entire data set even in presence of missing or incomplete observations over time [24, 25].

The models were implemented in the statistical package MLwiN 2.02 [26] and estimated using maximum likelihood estimation procedures (i.e. RIGLS). Model comparison was carried out using the deviance statistic which is calculated as minus twice the log-likelihood. Difference between the deviance statistics obtained from two alternative models were contrasted against a chi-square distribution with degrees of freedom equal to the difference between the number of parameters in the two models. The lower the deviance, the best the model fit.

Table 1 Resource use unit costs

Item	Unit	Unit cost			Source
		£, 2003	US$, 2003[a]	€, 2003[a]	
Hospital inpatient stay	Day	172[b]	269	236	NHS reference cost
Specialist contact	Visit	92[b]	144	126	CIPFA 2002[c]
GP contact	Visit	38[d]	59	52	PSSRU 2004
Nurse contact	Visit	13[d]	20	18	PSSRU 2004
Residence stay	Week				
Residential care		363[e]	567	498	PSSRU 2004
Sheltered accommodation		217[f]	339	298	PSSRU 2004
Nursing accommodation		480[e]	750	659	PSSRU 2004
Surgery					
Hip fracture	Surgery	5,028[g]	7,856	6,898	NHS reference cost
Arm fracture	Surgery	1,872[h]	2,925	2,568	NHS reference cost
Wrist fracture	Surgery	1,167[i]	1,823	1,601	NHS reference cost
Vertebral fracture	Surgery	5,330[b]	8,328	7,312	NHS reference cost
Home help	Hour	11	17	15	PSRRU

[a] Conversions estimated using OECD Parity Purchasing Prices (2003)

[b] Fully allocated cost, derived from average of excess bed days for non-elective admissions (upper limb fracture, lower limb fracture, pelvis minor fracture, neck of femur fracture)

[c] Up rated to 2003, using inflation index from PSSRU

[d] Average cost of surgery and home visits

[e] Average weekly cost of accommodation in private and voluntary residential care

[f] Average weekly cost of housing association and local authority shelter accommodation

[g] Average fully allocated cost of bilateral primary hip replacement, closed pelvis fracture and neck of femur fracture with hip replacement

[h] Average fully allocated cost of surgery for upper limb fracture or dislocation

[i] Fully allocated cost of surgery following minor fracture or dislocation

In the risk factors study, only two measurements per individual were available. In this case, we used an analysis of covariance (ANCOVA) model, regressing the value of the outcome variable at the end of the study against a set of baseline covariates, including the baseline value of the outcome.

Mean EQ-5D decrements associated with falls and fractures estimated from the multilevel model were combined with life expectancy data for the UK general population of women aged 70 to estimate the quality-adjusted life years lost for women with falls and fractures. Quality-adjusted life years (QALYs) estimation was performed assuming a linear interpolation between time points and a constant EQ-5D score over the remaining life expectancy of British women aged 70 years and over.

A simple analysis of resource use data was undertaken; this was dictated by the fact that very few events (i.e. falls and fractures) were reported to have occurred in the last 12 months by the participants in the calcium and vitamin D_3 trial who had agreed to be contacted again for research purposes. Hence, a simple account of the healthcare resource use associated with each event was preferred to any regression-based analysis.

Results

Impact of falls and fractures on HRQoL

Table 2 reports the baseline characteristics of women who took part in each of the three case studies. These are used in the analyses presented in the following section. In view of the fact that a difference in treatment effect was neither found in the hip protector or the calcium and vitamin D_3 trials, the present analysis does not distinguish between treatment groups.

Compared to the participants of the calcium and vitamin D_3 and the *epidemiological risk factors* studies, women in the hip protector trial were older, had lower bodyweight, were more likely to have had previous fractures and falls and were current smokers. Despite this, women in the hip protector study had only marginally lower HRQoL at baseline; see Table 2.

The hip protector trial

Of the 4,196 subjects who participated in the hip protector [18] trial, 3,223 had a baseline measurement of HRQoL described by the EQ-5D, with response rate at 6, 12 and 18 months being respectively 89%, 83% and 82%. The longitudinal nature of the data collection means that individual-level observations are expected to display a certain degree of correlation.

A graphical exploration of inter-temporal trends in the mean EQ-5D, SF-12 mental and physical summary scores and their 95% confidence intervals indicated low variability associated with EQ-5D scores over time. This suggests that a model linear in the covariate 'measurement occasion' may be adequate. Unlike the EQ-5D, both mental and physical scores of the SF-12 showed a statistically significant sharp departure from baseline to 6 months and a linear trend after that (data not presented but can be requested from authors).

Table 3 reports the results of the models explained in the 'Materials and methods' section applied to EQ-5D data.

Table 2 Participants' baseline characteristics in each of the case studies

Baseline variable	Hip protector trial [18] (*N*=4,196)	Calcium and vitamin D_3 trial [12] (*N*=3,314)	Epidemiological risk factors study [20] (*N*=4,292)
Age, mean (SD)	77.8 (5.5)	76.8 (5.0)	76.9 (5.1)
Weight in kg, mean (SD)	61.0 (11.4)	64.9 (12.0)	64.2 (11.0)
Proportion <58 kg	45.5%	32.7%	29.1%
Proportion with prior fractures (yes/no)	67.7%	58.6%	43.6%
Proportion poor/fair health status (self assessed)	38.4%	37.8%	27.9%
Proportion smoker (yes/no)	12.4%	7.8%	7.8%
Proportion whose mother had hip fracture (yes/no)	12.1%	16.3%	11.6%
Proportion reporting falls in previous 12 months (yes/no)	43.2%	33.9%	29.3%
EQ-5D score, mean (SD)	0.63 (0.29)	0.69 (0.25)	0.75 (0.23)
SF-12 physical score, mean (SD)	39.6 (5.8)	37.9 (6.7)	42.6 (11.4)
SF 12 mental score, mean (SD)	48.7 (6.9)	51.2 (10.0)	52.9 (8.6)
Baseline 'fear of falls' (%)			
None of the time	36	44	41
A little of the time	18	29	33
Some of the time	16	14	15
A good bit of the time	9	6	5
Most of the time	9	4	4
All of the time	12	3	2

Table 3 Analysis of EQ-5D scores

Fixed parameters	Hip protector		Calcium and vitamin D$_3$		Risk factors
	Null model	Full model	Null model	Full model	Full model
Constant (β_0)	0.6247 (0.0064)	0.2694 (0.0114)	0.7095 (0.0060)	0.2851 (0.0114)	0.30 (0.035)
Time (β_1)	−0.0004 (0.0004)	−0.00007 (0.0004)	−0.0004 (0.0003)	0.0001 (0.0003)	
Smoker (β_2)	–	−0.0297 (0.0101)[a]		−0.0207 (0.0124)	−0.005 (0.026)
Weight in kg[b] (β_3)	–	−0.0001 (0.0003)		−0.0006 (0.0002)[a]	−0.001 (0.0005)[a]
Age[b] (β_4)	–	−0.0017 (0.0006)[a]		−0.0018 (0.0006)[a]	−0.003 (0.001)[a]
Fear of fall (β_5)					
A little of the time	–	−0.0308 (0.0069)[a]		−0.0247 (0.0056)[a]	−0.044 (0.01)[a]
Some of the time	–	−0.0670 (0.0076)[a]		−0.0606 (0.0067)[a]	−0.075 (0.01)[a]
A good bit of the time	–	−0.1035 (0.0092)[a]		−0.1033 (0.0092)[a]	−0.105 (0.03)[a]
Most of the time	–	−0.1521 (0.0102)[a]		−0.1422 (0.0109)[a]	−0.161 (0.05)[a]
All the time	–	−0.1761 (0.0116)[a]		−0.1959 (0.0144)[a]	−0.253 (0.09)[a]
Baseline EQ-5D score (β_6)		0.6566 (0.0118)[a]		0.6545 (0.0127)[a]	0.636 (0.04)[a]
Interaction falls–time (β_7)	–	−0.0002 (0.0005)		−0.0030 (0.0008)[a]	−0.004 (0.01)[c]
Interaction fractures–time (β_8)	–	−0.0045 (0.0009)[a]		−0.0062 (0.0011)[a]	−0.021 (0.03)[c]
Level two random parameters					
$\sigma^2_{u_0}$ (constant)	0.06699	0.01547	0.04892	0.01313	
$\sigma^2_{u_1}$ (time)	–	0.00001	–	0.00003	
σ_{01}	–	0.00005	–	−0.00010	
Level one random parameter					
σ^2_{ε}	0.02337	0.02235	0.01834	0.01694	
Deviance (−2*loglikelihood)	−689	−3,817	−2,396	−5,098	

Values are regression coefficients (SE)

[a] P value <0.05

[b] Centred with respect to the sample overall mean

[c] No time interaction, this coefficient is only associated with falls/fractures

The starting point of the analysis was to fit a 'null model' including measurement occasion ('Time') as the only explanatory variable. By separating the total variance into the component related to *between*-patients variation and *within*-patient variation, this model facilitated the estimation of the *intra cluster correlation* (ICC) coefficient, calculated as $\left(\sigma^2_{u_0} \big/ \left(\sigma^2_{u_0} + \sigma^2_e \right) \right)$, which represents the degree of similarity between measurements taken from the same individual over time. The ICC for the null model is 0.74. The null model does not identify any important trend over time in the EQ-5D score.

The 'full model' results of which are reported in Table 3 introduces a set of explanatory variables, representing factors that are expected to have an impact on the risk of fractures (and consequently to affect HRQoL), together with the time-by-fracture and time-by-fall interaction terms. Several considerations can be made from the results of this model fitted to data from the hip protector study. First of all, most covariates have a statistically significant impact on HRQoL as measured by the EQ-5D questionnaire. The coefficient of the variable current smoker has the expected negative sign suggesting that, all things being equal, smokers (on average) had a lower average HRQoL. Similarly, patients older than the overall mean in this trial (see Table 2) have on average

lower HRQoL, with a decrease in the EQ-5D score of 0.0017 for every year departing from the sample mean. Neither bodyweight nor measurement occasion has a statistically significant impact on the EQ-5D score. A major role in affecting the EQ-5D score is played by the intensity of the 'fear of fall', with statistically significant quality of life decrements associated with increasing level of anxiety. With regard to the impact of fractures and falls over time, the model suggests that these events have a (statistically significant in the case of fractures) negative impact on HRQoL, as measured by the EQ-5D score.

The calcium and vitamin D$_3$ prevention trial

Of the 3,314 women who participated in the calcium and vitamin D$_3$ study, [12] 3,240 had a baseline measurement of EQ-5D, with response rate at 6, 12 and 18 months being 79%, 74% and 59%, respectively. As for the hip protector trial, there is high correlation between the outcome variables at each time point. Inspection of the baseline characteristics of women enrolled in this trial (Table 2) indicates that this sample is somewhat similar to the sample of women who participated in the hip protector study. Compared to participants in this study, individuals enrolled in the calcium and

vitamin D_3 trial were 1 year younger, had a greater bodyweight by 4 kg, had experienced less falls in the previous 12 months, were less likely to be a smoker (7.8% smoked), had a lower number of past fractures and had a better HRQoL at baseline as measured by the EQ-5D score. In this trial, no reduction in the fear of falls over time was observed. In fact, while 44% of women reported to have no concern at all regarding the fear of fall at baseline, this percentage falls to 31% at 6 months, 28% at 12 and 27% at 18 months.

Table 3 reports the analysis of EQ-5D scores from participants in the calcium and vitamin D_3. There is no significant trend over time in the EQ-5D score. The full model introduces a set of baseline covariates in the attempt to reduce some of the between-individuals variation observed in the null model. This model suggests that smoker women with lower bodyweight and older than this trial's overall mean for weight and age (see Table 2) have statistically significantly lower HRQoL as measured by the EQ-5D score. As expected, baseline EQ-5D is a strong predictor, and this does not raise any particular issue. Measurement occasion is still not statistically significant. The change in the algebraic sign of the parameter Time between the two models is probably due to chance. As found in the hip protector trial, one of the most important factors affecting the HRQoL in women is their fear of falls. Table 3 suggests that the higher the fear of fall, the lower the EQ-5D score, with a 20% reduction in women who are worried all the time about falls. This is to be expected as the dimension *anxiety/depression* has a strong impact on the EQ-5D score, with reductions of 0.071 for moderate anxiety and of 0.231 for severe anxiety [27]. The full model represents a significant improvement with respect to the null model as measured by the change in deviance of 2,702 and reduction of the between-individuals' unexplained variability. The findings regarding the impact of falls and fractures on EQ-5D scores support the expectation that both events are associated with a decrement in HRQoL, with fractures involving a much greater loss in quality of life. In particular, the results of this model suggest that fractures have twice the impact of falls in reducing HRQoL (−0.0062 versus −0.003).

The epidemiological risk factors cohort study

The epidemiological risk factors cohort study [20] provides the third piece of evidence regarding the role that falls and fractures play in affecting women's HRQoL. As mentioned previously, the risk factors study was a longitudinal survey, which recruited women with and without risk factors for fractures at baseline. Given, only two observations of HRQoL (baseline and 12 months) were available for each individual in this sample. The analysis was therefore conducted using a simple ANCOVA approach.

Table 3 reports the results of the regression model, including all covariates. This analysis suggests that women who are currently *smokers* have on average a lower EQ-5D score, although the impact of smoking impact is not statistically significant. Consistently, with the analyses presented so far for the other case studies, the evidence provided by the risk factors study suggests that women older than the trial mean (76.9) patients have a statistically significant lower EQ-5D score, with the opposite being true for women younger than 76.9 years old. Similarly, women whose bodyweight is greater than the overall mean (64.2 kg) have a statistically significant lower EQ-5D score. Furthermore, as it was found in the other data sets, the greater the fear of fall, the lower the EQ-5D score.

Finally, both falls and fractures were associated with a reduction in EQ-5D, but this was not statistically significant. This result might be related to the small percentage of fractures in the 12 months of the study (e.g. 9%), although percent of falls was 26%. In addition, in the epidemiological risk factors study, the time interval for the measurement of the EQ-5D is twice as long (12 months) as the one used in the *hip fracture* and the calcium and vitamin D_3 studies (6 months); this could have diluted the effect of falls and fractures in self-reported HRQoL.

Impact of falls and fractures on healthcare resource use and costs

The overall response rate to the postal fall and fracture questionnaire was 93% (1,110/1,190); valid responses were provided in 99.6% of these cases. Eight hundred individuals (72.3%) reported not having had a fall or a fracture in the previous 12 months. Of the 302 respondents (27.2%) who reported falls in the previous 12 months, 62 (20.5%) said their fall resulted in a fracture. The incidence of fractures associated with an event other than a fall was 0.3%; only three individuals reported to have had a fracture without having experienced a fall.

Table 4 reports summary statistics of NHS contacts related to falls with and without fractures in the calcium and vitamin D_3 trial. Nine of the 237 women experiencing a fall without a fracture were also hospitalised, while 25 of the 37 women who reported a fracture following a fall were also hospitalised. As expected, falls which did not lead to a fracture required only limited health care resources. On the other hand, falls leading to fractures were more often associated with large resource use (e.g. hospital stay, surgery, etc.). As expected, only a small minority of falls led to hospital in patient stay (4% of cases) as opposed to a third of women who reported a fracture. Most women had an inpatient length of stay, which ranged between 1 and 32 days (mean 9.6). In two cases, the fracture required day hospital admission only. Only a third of women who

Table 4 Health care resource use in the last 12 months related to falls and fractures in the calcium and vitamin D_3 trial (N=1,110)

Item of resource use	Falls only (N=237)	Falls and fractures (N=62)
Hospital stay?		
Yes, N (%)	9 (4)	25 (33)
Day admissions, N (%)	0	2 (8)
Length of stay, mean (range)	6.7 (1–28)	9.6 (1–32)
Seen a doctor?		
Yes, N (%)	74 (30)	54 (77)
How many times, N (%)		
1–2	56 (75)	18 (33)
3–4	10 (13)	27 (50)
>4	8 (12)	9 (17)
Seen a nurse?		
Yes, N (%)	25 (9)	22 (31)
How many times, N (%)		
1–2	16 (64)	16 (73)
3–4	3 (12)	2 (9)
>4	6 (24)	4 (18)
Change of residence?		
Yes, N (%)	3 (1)	5 (8)
Had surgery?		
Yes, N (%)	0	11 (18)
Received help at home?		
Yes, N (%)	25 (11)	17 (29)
How often (weeks)		
Every day	6	8
Once a week	11	3
Twice a week	3	2
Every fortnight	1	1
Missing	4	2
Seen GP for any reasons?		
Yes, N (%)	210 (86)	52 (84)
How many times, mean (SD)	4 (3)	5 (4)
Seen hospital doctor for any reasons?		
Yes, N (%)	128 (53)	49 (78)
How many times, N (%)	3 (2)	3 (2)
Hospital stay for any reason?		
Yes, N (%)	52 (23)	25 (33)
Day admissions, N (%)	1	3
Length of stay, mean (range)	7.4 (7.2)	8.2 (7.7)

Unless otherwise stated numbers reported are quantities (percent)

experienced a fall went to see either a GP or hospital doctor, as opposed to 77% of women who had a fracture. The latter group had more frequent contacts with their doctor, unlike nurse contacts which were similar between the two groups. Only eight women in total reported a change of residence in the last 12 months, and five responders related this event to their fracture. In this sample, the change in residence had little if no impact on the NHS budget, as all women except one said that they went to live with relatives. Finally, the need to use home help was similar between the two groups.

Three final questions were also included in questionnaire, which were aimed to ascertain whether responders who had experienced a fall and/or a fracture had a higher propensity to seek health care contacts. These questions related specifically to GP and hospital (doctor and inpatient stay) contacts. The two groups seemed to be balanced in terms of their GP contacts, with approximately 85% of women in each group reporting one or more GP contacts in the previous 12 months. Similarly, hospital inpatient stay for any reason was similar between women reporting a fall and those experiencing a fracture. The only difference was in the proportion of people reporting having hospital doctor contacts. Women who reported a fracture in the previous 12 months had higher frequency of outpatient contacts (78%) than those reporting to have had a fall (53%).

Estimates of health care cost by cost category (hospital stay, doctor visit, nurse visit, home help) and by event and/or fracture type (fall, hip, wrist, arm, vertebral and other fracture) are reported in Table 5. Hospital stay and home help were the two main resource categories contributing to the cost of falls and fractures. Whilst treatment cost associated with fall was some how lower than that associated with a fractures (any type), the magnitude of this difference was not as large as might have been expected.

Burden of falls and fracture

Falls represented both a significant cost and quality of life burden. Few fallers were admitted to hospital; however, because the incidence of falling is so much higher than the incidence of fractures, even relatively small proportions will represent a high cost burden. In this study, we found that 4% of fallers were admitted to hospital and 30% saw a doctor (Table 4). In contrast, those who fell and fractured did have a much higher use of health care resources than the fallers with 33% having to be admitted to hospital. Because of this higher cost, fractures still represent a higher cost burden to society than falls (Table 6),

In terms of the quality of life burden, the greatest burden of loss of quality of life is for fear of falling rather than the fall or fracture. Many women in our study had a significant fear of falling, and modelling this fear to a cohort of 10,000 women, we found that by far, the largest quality of life lost was due to this fear of falling. The 597 QALYs lost per year significantly exceeded that lost from both falling and fracture combined (Table 6).

Discussion

In this study, we have analysed several large datasets that collected generic quality of life outcomes and costs on older

Table 5 Health care cost in the last 12 months related to falls and fractures in the calcium and vitamin D$_3$ trial (N=1,110)

Cost category	Falls only			Falls and fractures		
	£, 2003	US$, 2003[a]	€, 2003[a]	£, 2003	US$, 2003[a]	€, 2003[a]
Hospital stay	1,306 (172–4,813)	2,041 (269–7,520)	1,792 (236–6,603)	1,769 (1,500)	2,764 (2,344–0)	2,427 (2,058–0)
Doctor visit	44 (99)	69 (155)	60 (136)	179 (207)	280 (323–0)	246 (284–0)
Nurse visit	85 (0–580)	133 (0–906)	117 (0–796)	31 (63)	48 (98)	43 (86)
Change of residence	NA	NA	NA	NA	NA	NA
Surgery						
Home help	4,873 (858–12,053)	7,614 (1,341–18,833)	6,685 (1,177–16,535)	7,807 (858–12,053)	12,198 (1,341–18,833)	10,710 (1,177–16,535)
	Number of events			Mean (SD)		
Fall only	243			1,088 (2,542)	1,700 (3,972)	1,493 (3,487)
Falls leading to fracture[b]						
Hip	10			15,133 (364–39,793)[c]	23,645 (569–62,177)	20,761 (499–54,591)
Wrist	7			2,753 (440–12,619)[c]	4,302 (688–19,717)	3,777 (604–17,312)
Arm	10			1,863 392–12,684)[c]	2,911 (613–19,819)	2,556 (538–17,401)
Vertebral	2			1,331 995–1,667)[c]	2,080 (1,555–26,042)	1,826 (1,365–22,865)
Other (without surgery cost)	33			3,498 (76–16,695)[c]	5,466 (119–26,086)	4,799 (104–22,903)

[a] Conversions estimated using OECD Parity Purchasing Prices (2003)

[b] These estimates are to be treated with caution given the small number of observations available

[c] Min–max

women who were at risk of falling and fracture. We have shown that fractures are a cause of significant cost and morbidity to older women. These results support other studies [28–31]. A comparison of our cost estimates for hip and vertebral fracture with those available in the literature indicated that our estimates were within the confidence limits of earlier studies [29, 32]. Estimates of acute hospitalisation costs for hip fracture (£12,163) from a more contemporary study [8] indicate that our estimate may be underestimating the true hospitalisation costs for hip fracture. Conversely, our estimates for wrist and arm

fracture were considerably higher than previously reported. Given the small number of fracture events included in our sample and our inability to confirm outcomes and consumption of resources with the participant's GP, these results should be taken with caution.

We have also estimated a cost for a non-fracture fall. The cost of a non-fracture fall was unexpectedly high, amounting to about the third of a cost of wrist fracture or half of a cost of vertebral fracture (Table 5). It is possible that the costs of the falls might be biased towards the higher cost falls. Falls that had more serious physical and financial

Table 6 Estimated QALY loss (based on results of the EQ-5D analysis from the hip protector trial) and costs associated with falls, fractures and fear of falls

	QALYs loss (×10,000 women)	Cost (×10,000 women)		
		£, 2003	US$, 2003[a]	€, 2003[a]
Fall	30	10,880,000	17,000,000	14,926,000
Fracture	62	49,568,871	7,7451,360	68,002,294
Fear of fall[b]	597	–	–	–

[a] Conversions estimated using OECD Parity Purchasing Prices (2003)

[b] Weighted average, obtained multiplying the disutility associated with the various levels of fear of fall from Table 2 by the baseline distribution of the fear of fall in the hip protector study

consequences, such as having to be seen by a GP, are likely to have been remembered and reported more than a fall that did not require any medical assistance. Therefore, we may have overestimated the costs of the 'average' fall. However, our estimate of falls is not too dissimilar to that reported from previous cross-sectional studies, where the fall rate in women aged 70 to 74 and 75 to 79 has been estimated as 26% and 33%, respectively [33].

Fear of falling was the largest cause of morbidity in this population of women. The fear of falling was the equivalent of the 6% decrement in a QALY per woman per year. In contrast, the QALY lost due to fracture was only a tenth of this amount.

Previous research into the fear of falling has found it to have a significant impact on quality of life. Cumming and colleagues in a study of 528 people in Australia found that fear of falling was a significant predictor of poor quality of life [34]. Our study confirms and extends those findings. First, our study is a sample from the community, whereas the Australian study recruited participants from hospitals. Also, in our study, we have measured quality of life with a measure of utility (the EuroQol-5D), which allows the burden of fear of falling to be converted to a single measure of HRQoL. Similarly, a recently published RCT of fall prevention programmes and quality of life in the elderly found evidence that improvements on HRQoL associated with exercise training were matched with reductions in self-reported fear of falling [35]. Unlike the other two fall prevention programmes evaluated in this study (education and home assessment and modification), individuals on exercise training were the only ones consistently reporting reductions in their fear of falling overtime. This coincides with our result that fear of falling is a major factor influencing quality of life in the elderly.

Our study does have some weaknesses that must be acknowledged. For the quantification of falls and fractures, we relied on self-report via postal questionnaire. Whilst this may be a less accurate form of outcome assessment—subject to under or over reporting—other methods such as telephone interviews and collection of data from clinical records required higher human and financial resources [36, 37]. Furthermore, there is evidence supporting the use of self-report of fractures in elderly populations as a reasonably accurate mean to collect fracture data when the recall interval is shorter than 2 years [38]. Having said that, our inability to confirm the occurrence of a fall /fracture implies that potential ascertainment bias cannot be fully discounted.

Although we recruited participants from the community, most people we sampled either refused or could not participate in the study. Therefore, we may have sampled a relatively healthy proportion of the population as such 'volunteer' bias tends towards including healthier individuals. Our results may have been different if we could have recruited and retained a true random sample of older women from the population. This issue should be addressed in future studies. Similarly, a recently published study proposes an algorithm to map the health states described in the SF-12 into a preference-based score [39]; the impact of fear of falling in this alternative score shall be the subject of a future study. Qualitative research may be used to gain a deeper understanding of the main sources for fear of falling related anxiety reported by the participants in the three case studies used here.

It could be argued that the impact of fractures on HRQoL depends on whether it is the first, second, third, etc. fracture event. The datasets available to us did not contain sufficiently detailed information to allow us to explore this issue, but this could be addressed in future prospective studies. Finally, our results consider only women; however, there is some evidence to suggest that the mortality rate after hip fracture is higher in men than in women [40]. Furthermore, the same study found that the proportion of years of life lost is higher for men, which in turn suggests that the impact of hip fractures of survival is worse for men. Consequently, had men been included in this study, we may had observed a higher impact on HRQoL associated with both falls and fractures. This could be explored in a future study including both men and women.

In summary, we have used an opportunistic sample of women to assess the impact of falls, fracture and fear of falling on costs and quality of life. We have found that the main burden of morbidity is due to fear of falling rather than falls or the sequelae of falls. Consequently, interventions aimed at reducing fear of falling may produce large quality of life gains, and this may be a cost-effective approach to increasing quality of life in society. Future health policy programmes aimed at improving/maintaining HRQoL in the elderly should consider evaluating interventions such as exercise programmes [35] that could potentially positively influence both fear of falling and fall prevention.

Conflicts of interest None.

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